

LAN Segmentation and IP Addressing



LAN Segmentation & Networking Essentials

Internetworking Fundamentals

- Internetworks are the communication structures that work to tie Local Area Networks (LAN) and Wide Area Networks (WAN) together.
- Primary goal is to move information anywhere quickly upon demand and with complete integrity. Must be able to connect many different networks together to serve the organizations needs regardless of the type of physical media involved.

Internetworking Devices

- LANs were designed to operate in limited geographical areas, such as one floor of a building, or a single building.
- LANs connect PCs together so that they can access network resources.
- A LAN connects physically adjacent devices on the network media or cable.
 - LAN Devices include: Repeaters, Bridges, Hubs, Switches, Routers, and Gateways.

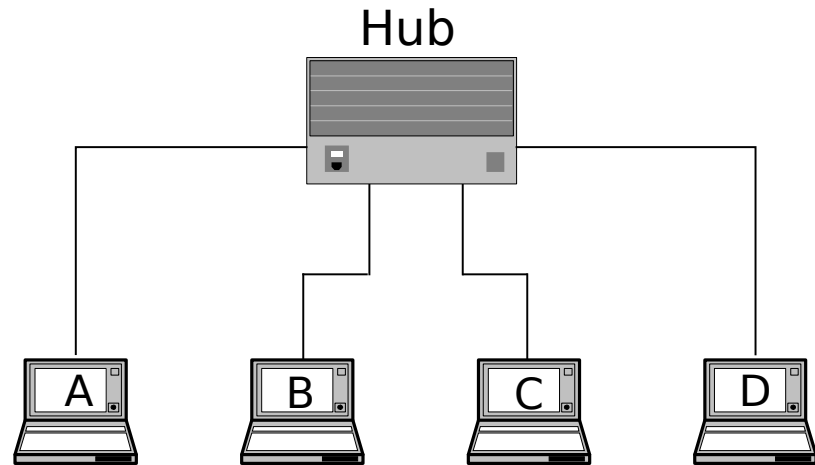
Internetworking Devices

Cont.

- WANs extend beyond the LAN to connection networks located in different building, cities, states, and countries together.
- WANs are connected over ***serial*** lines.
 - WAN devices include: Routers, ATM Switches, X.25 and frame relay switches, modems, Channel Service Unit/Data Service Units (CSU/DSU), communication servers, and multiplexors.

Hubs

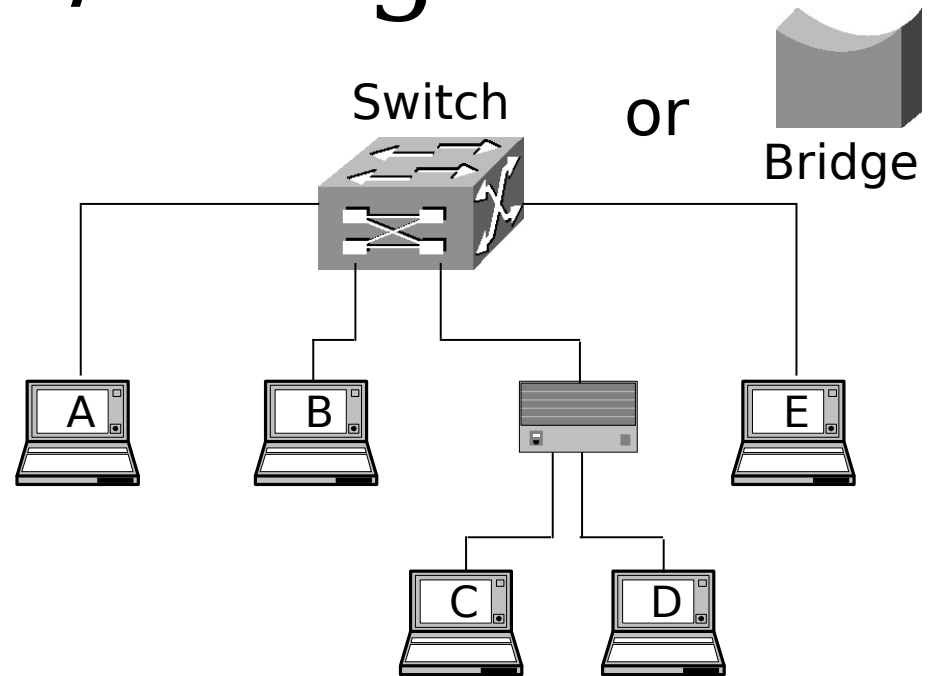
APPLICATION
PRESENTATION
SESSION
TRANSPORT
NETWORK
DATA LINK Physical Layer



- All devices are in the same collision domain
- All devices are in the same broadcast domain
- All devices share the same bandwidth

Switches/Bridges

APPLICATION
PRESENTATION
SESSION
TRANSPORT
NETWORK
DATA LINK Physical LLC/MAC)

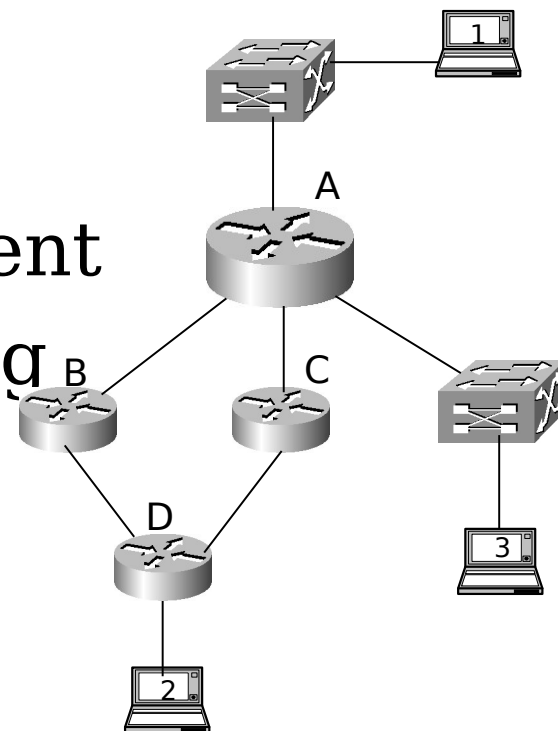


- Each Segment has its own collision domain
- All segments are in the same broadcast domain
- Listening Learning Filtering and

Routers

APPLICATION
PRESENTATION
SESSION
TRANSPORT
NETWORK
DATA LINK (Physical Layer) (MAC)

- Broadcast control
- Multicast control
- Optimal path determination
- Traffic Management
- Logical addressing
- Connects to WAN services



Ethernet: Collisions

- Certain level of collisions are expected on CSMA/CD LANs
- Excessive collisions can result from faulty components or overloaded segments
 - **Bad or excessively long cables**
 - **Bad NICs or transceivers**
- Establishing a baseline is helpful to determine normal levels
- Local collisions
 - **Occur on local LAN segment**
 - **Detected by circuitry in LAN interfaces**
- Remote collisions
 - **Occur on other side of repeater nodes**

CSMA/CD

1. Sender is ready to send the frame. It listens to detect whether any frame is currently being received.
2. If Ethernet is silent, the devices begins to send the frame.
3. The sending device begins to listen to ensure that the frame it is sending does not collide with a frame that another station is sending.
4. If no collision occurs, the bits of the sent frame are received back successfully.
- 5 If a collision occurred, the device sends a jam signal and then waits a random amount of time before repeating the process.

IP Addressing & Classes

Table of Contents

- IP Addressing
- Subnetting
- Questions
- Summarization
- VLSM (Variable Length Subnet Masking)

Binary to Decimal Conversion

- | | | | | | | | |
|------------|-----------|-----------|-----------|----------|----------|----------|----------|
| <u>128</u> | <u>64</u> | <u>32</u> | <u>16</u> | <u>8</u> | <u>4</u> | <u>2</u> | <u>1</u> |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

00000000 = 0
- | | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
|---|---|---|---|---|---|---|---|

11111111 = 255
- | | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
|---|---|---|---|---|---|---|---|

00001111 = 15
- | | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
|---|---|---|---|---|---|---|---|

01010101 = 85

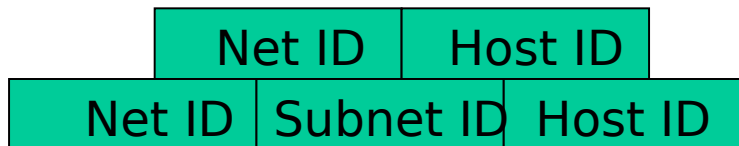
Binary (Cont.)

- 00000000 = 0
- 10000000 = 128
- 11000000 = 192
- 11100000 = 224
- 11110000 = 240
- 11111000 = 248
- 11111100 = 252
- 11111110 = 254
- 11111111 = 255



IP Addressing

- 32 BITS - 4 BYTES -
- MUST BE UNIQUE FOR EACH HOST IN NETWORK (8 BITS = 1 BYTE)
 - 192.168.20.10
 - 192.168.31.33
- 2 [3] PORTIONS
 - Network portion - Relative to the class of IP. Identifies the network and is common to all devices attached to that network.
 - Host portion - also relative to class as well as identifies a particular device attached to that network.
 - [Subnet portion]



Addressing/Classes

XXX.XXX.XXX.XXX **n = network h=host address**
▲**192.156.2.169 (IPv4)**

●**Class A** nnn.hhh.hhh.hhh **1 - 126**
-Only 126 networks, but 16,777,214 hosts
apiece
▫**127.0.0.1 = Local loop back address**

●**Class B** nnn.nnn.hhh.hhh **128 - 191**
▫16,384 networks with 65,534 hosts apiece

●**Class C** nnn.nnn.nnn.hhh **192 - 223**
▫2,097,152 networks with 254 hosts apiece

●**Class D - used for multicasting (audio/video)**

●**Class E - currently reserved / future use**¹⁶

Class Conversion

[illegible]

A 0 0 0 0 (2²⁴-2) = 16,777,214

0	0	0	0	0	0	0	0	-2 for broadcast and network
0	1	1	1	1	1	1	1	
2 = 126 networks								

$2^7 - 2 = 126$ networks

Decimal Range 1-126

0 and 127 are reserved

$$\underline{\mathbf{B}} \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} = \mathbf{0} \quad (2^{16-2}) =$$

1 **0** 1 1 1 1 1 1. 0 0 0 0 | 0 **65,524 hosts per network**

$2^{14} = 16,384$ networks

Decimal Range 128-191

C	1	1	0	0	0	0	0	0.	0	0	0	0	0	0	0	0.	0	0		0	(20802)	0
----------	----------	----------	----------	----------	----------	----------	----------	-----------	----------	----------	----------	----------	----------	----------	----------	-----------	----------	----------	--	----------	------------------	----------

1 1 0 1 1 1 1 1. 0 0 0 0 0 0 0 0. 0 0 0 0 = 254 0 0

$2^{21} = 2,097,152$ networks

Decimal Range 192-223

host per network

Decimal to Binary Example

$$192.156.69.0 =$$

128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	.	128	64	32	16	8	4	2	1
1	1	0	0	0	0	0	0	1	0	0	1	1	1	0	0	.	0	1	0	0	0	1	0	1
128+64 = 192								128+16+8+4 = 156								64+4+1 = 69								

The binary representation of 192.156.69.0 is 11000000.10011100.01000101.00000000.

Let Practice!!

Reserved IP Addresses

- IP address for Hosts cannot have:

ALL 1's or ALL 0's (binary) in the NETWORK portion

OR

ALL 1's or ALL 0's (binary) in the HOST portion

- All 1's in the host portion of a target IP address signifies a Broadcast
- All 0's in the host portion of a IP address identify a subnet or network

- Network: 138.156.0.0 =
10001010.10011110.00000000.00000000
Broadcast: 138.156.255.255 =
10001010.10011110.11111111.11111111
Host: 138.156.100.100 =
10001010.10011110.01100100.01100100

IP Addresses

- Address assignment planning
- Assigned by the Node Site Coordinator
- Draw out your network
- Same “physical” net means same “IP Network”
- Each "interface" has a "unique" IP address
- Don't assign reserved addresses

Non Routable Addresses:

- 10.0.0.0 to 10.255.255.255
- 172.16.0.0 to 172.31.255.255
- 192.168.0.0 to 192.168.255.255

TCP/IP SUBNETTING

Terminology

- Address Mask - All network bits set to 1 and all host bits set to 0
- Subnet - A subnetwork of a major class A, B, C address space
- Subnet Mask - A mask longer than the standard address mask - determined by subnet scheme.

IP Address Terminology

- **NETWORK NUMBER**- When all host bits are turned off (0).
- **BROADCAST ADDRESS**- When all host bits are turned on (1).
- **HOST ADDRESS**- A unique IP address assigned to a workstation, interface or user, that is in between the network number and broadcast address.
- **SUBNET MASK**-Used to tell the machine what subnetting scheme is being implemented on the network. Found by turning all network bits on (1), including those host bits that have been given to the network side.
- **SUBNETTING** - Dividing up an entire Class network by sacrificing original host (H) bits to the network (N).

SUBNETTING

- WHAT IS IT?

Divides host (H) portion into smaller networks

- WHY?

Stops wasting network numbers

- WHO?

Node site coordinator

- WHAT DETERMINES?

Number of different physical networks and
number of hosts

Subnetting

- When you borrow bits from the main network address's host section, TCP/IP must be told which bits of the host section are borrowed to be used as the network address.

- We use a subnet mask to define the number of bits used to create additional networks.

- **Remember** - the more bits used to define the mask, the fewer the

Default Subnet Mask

Your network has a subnet mask even if it doesn't have

CLASS A DEFALUT = 255.0.0.0

11111111.00000000.00000000.00000000

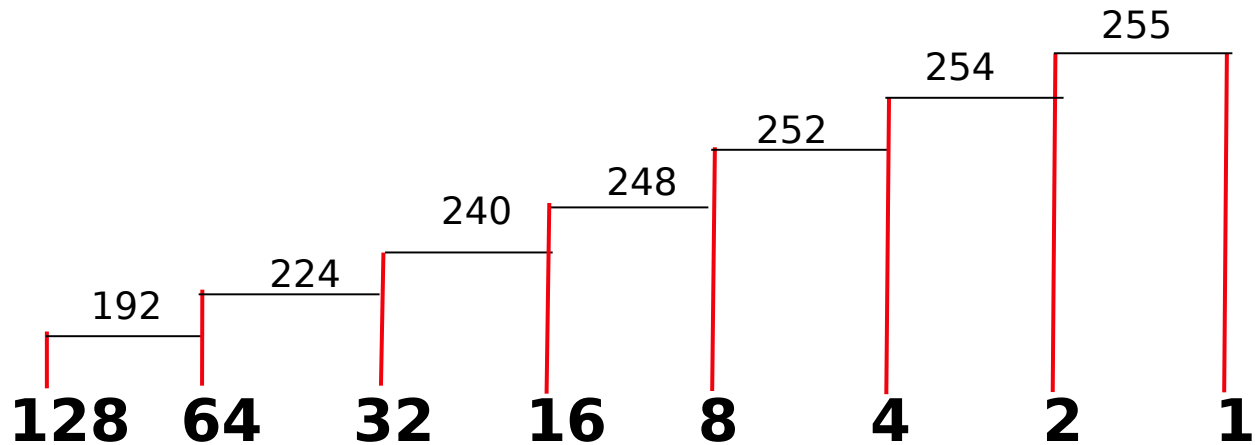
CLASS B DEFAULT = 255.255.0.0

11111111.11111111.00000000.00000000

CLASS C DEFAULT = 255.255.255.0

11111111.11111111.11111111.00000000

Subnet Bit Chart



* SUBNET BITS COME FROM THE **HIGHEST-ORDER BITS** TO THE LOW ORDER BITS OF THE **HOST FIELD**

How Subnetting Works

N | H
 128 64 32 16 8 4 2
 1 MASK =
 128+64+32+16
 240

16 - (2) # hosts
 per network
 - all 0's network
 - all 1's broadcast
 leaves 14 per net

N				H				
128	64	32	16	8	4	2	1	
0	0	0	1	0	0	0	0	16 Network
0	0	0	1	0	0	0	1	17 1st host
0	0	0		1	0	0	1	18
0	0	0		1	0	0	1	19
:	:	:		:	:	:	:	
0	0	0		1	1	1	1	31
Broadcast								
0	0	1		0	0	0	0	32

Determining Subnet Mask

192.156.69.0 = 11000000.10011100.01000101.00000000 Class C
 N.N.N.H

143.211.0.0 = 10001111.11010011.00000000.00000000 Class B

Subnet Mask is the address with every network bit turned on. This tells the router that you want to use some Host bits as network (subnet) bits.

192.156.69.0 = 11000000.10011100.01000101.00000000 Class C
 N.N.N.H

Subnet Mask = 11111111.11111111.11111111.00000000 255.255.255.0

with 4 bit = 11111111.11111111.11111111.11110000
 255.255.255.240

143.211.0.0 = 10001111.11010011.00000000.00000000 Class B
 N.N.H.H

Subnet Mask = 11111111.11111111.00000000.00000000 255.255.0.0

with 8 bit = 11111111.11111111.11111111.00000000

Subnetting Reference Charts

CLASS B (Assumes the first
and last networks aren't
usable)

# BITS	SUBNET MASK	# SUBNETS	# HOSTS
2	255.255.192.0	2	16382
3	255.255.224.0	6	8190
4	255.255.240.0	14	4094
5	255.255.248.0	30	2046
6	255.255.252.0	62	1022
7	255.255.254.0	126	510
8	255.255.255.0	254	254
9	255.255.255.128	510	126
10	255.255.255.192	1022	62
11	255.255.255.224	2046	30
12	255.255.255.240	4094	14
13	255.255.255.248	8190	6
14	255.255.255.252	16382	2

Subnetting Reference Charts

CLASS C

(Assumes the first
and last networks
aren't usable)

# BITS	SUBNET MASK	# SUBNETS	# HOSTS
2	255.255.255.192	2	62
3	255.255.255.224	6	30
4	255.255.255.240	14	14
5	255.255.255.248	30	6
6	255.255.255.252	62	2

Steps in Subnetting

192.168.25.45

27
192.168.25.45

255.255.255.224
Mask
192.168.25.??

1. Write Out the Subnet Mask

2. Answer What You Know

3. Write Out in Binary

4. Apply Logical Anding

5. Turn on all the host bits

128 64 32 16 8 4

2 1

1 1 | 1 0 0 0

0 0

0 0 | 1 0 1 1

0 1

0 0 | 1 0 0 0

0 0

0 0 | 1 1 1 1

1 1

Going Beyond The Octet

N																H															
32768	16384	8192	4096	2048	1024	512	256		128	64	32	16	8	4	2	1															
										64																					
									0	1	0	0	0	0	0	0	0.64 Network														
									0	1	0	0	0	0	0	1	0.65 1st host														
									0	1	0	0	0	0	1	0	0.66 2nd Host														
									:	:	:	:	:	:	:	:															
									0	1	1	1	1	1	1	1	0.127 Broadcast														
									1	0	0	0	0	0	0	0	0.128 Network														
									1	0	0	0	0	0	0	1	0.129 1st host														
32768	16384	8192	4096	2048	1024	512	256		128	64	32	16	8	4	2	1															
									0	0	0	0	0	0	0	0	4.0 Network														
									0	0	0	0	0	0	0	1	4.1 1st host														
									1	1	1	1	1	1	1	1	7.255 Broadcast														
									0	0	0	0	0	0	0	0	8.0 Network														

10 Bit

1022 Nets

62 Hosts

6 Bit

62 Nets

1022 Hosts

10 Bit
1022 Nets
62 Hosts

6 Bit
62 Nets
1022 Hosts

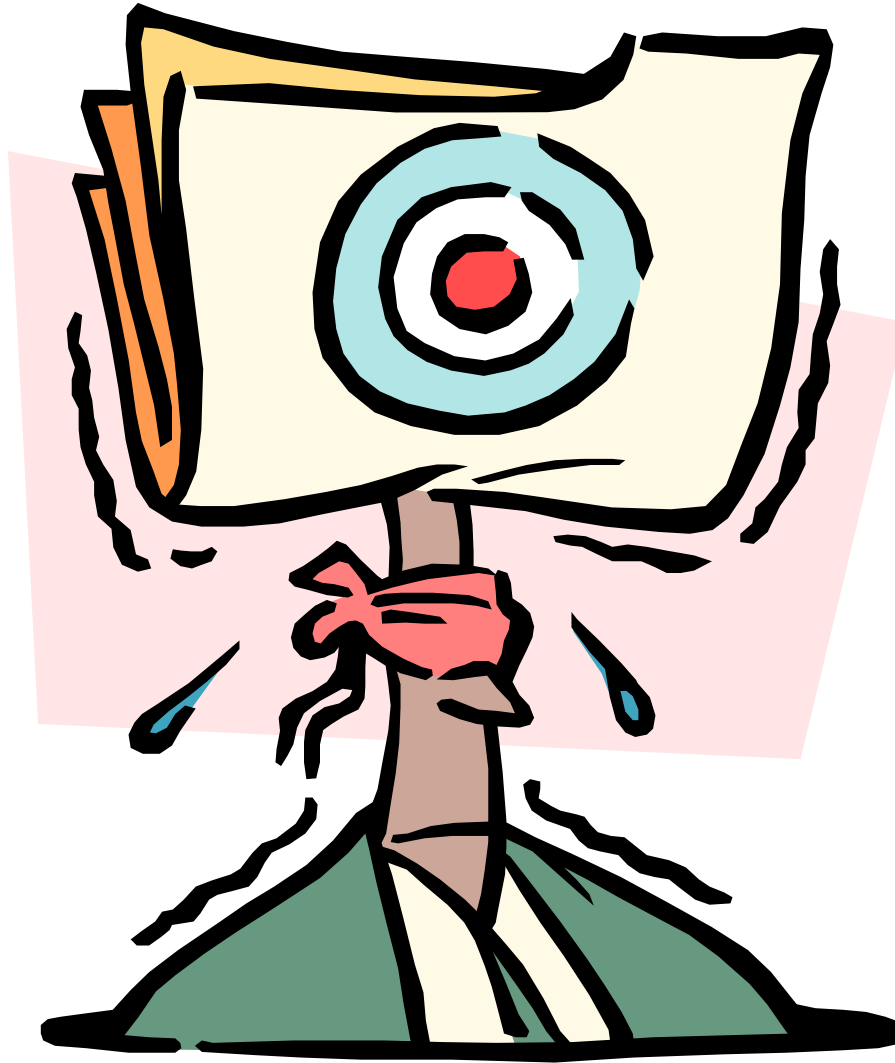
Finding A Host's Network

	N	H
Host: 192.156.69.78 =	11000000.10011100.01000101.01001110	
Subnet Mask 4 bit =	11111111.11111111.11111111.11111111	
Host Network ID # =	11000000.10011100.01000101.01001110	
Network bits total =	11000000.10011100.01000101.01001110	

which is not all 1's or all 0's.

Host bits = 1110 which is not all 1's or all 0's so it is legal, it is the
14th host on the .64 network.

Is there another way?



Five Questions

- 1. How many subnets?
- 2. How many hosts per subnet?
- 3. What are the subnets?
- 4. What are the valid hosts in each subnet?
- 5. What is the broadcast address of each subnet?

Begin to answer by...

1. Determine how many networks you need.
2. Find out how many hosts are required for each network (use the highest number of hosts).
3. Choose the subnetting scheme that will best support all networks (leave room for growth).
4. Assign network numbers.
5. Assign unique addresses to

Five Answers

- 1. 2^n = Amount of subnets.
- 2. $2^n - 2$ = Amount of hosts per subnet.
- 3. $256 - \text{Subnet mask} = \text{Base number}$.
- 4. Valid hosts are the numbers between the subnets, minus all 0's and all 1's.
- 5. Broadcast address is all 1's or the number before the next subnet.

Prefix Routing

- Means by which the Internet identifies the portion of the 32-bit TCP/IP address
 - /30 255.255.255.252
 - /29 255.255.255.248
 - /28 255.255.255.240
 - /27 255.255.255.224
 - /26 255.255.255.192
 - /25 255.255.255.128
 - /24 255.255.255.0
 - /23 255.255.254.0

Discontiguous Addressing

- Two networks of the same classful networks are separated by a different network address.

Summarization

- Allows contiguous networks to be grouped together and advertised as one large network
- Also known as supernetting

Supernetting/CIDR

- Supernetting and Classless Inter Domain Routing (CIDR) reduce routing tables by grouping or blocking networks.
- Determine common network bits
- Write networks out in binary
- Turn all common network bits to 1 to determine supernet

- Count number of common bits for CIDR mask

204.223.0.0 = 11001100.11011111.000000 00.00000000

204.223.1.0 = 11001100.11011111.000000 01.00000000

204.223.2.0 = 11001100.11011111.000000 10.00000000

204.223.3.0 = 11001100.11011111.000000 11.00000000 255.255.252.0 or /22

Supernet Mask	CIDR
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VLSM

- Variable Length Subnet Mask (VLSM) is the practice of using multiple network masks for the same network
- You must start with the largest blocks and divide those blocks into smaller subnets
- Allows backbone routing tables to be smaller, while giving the individual unit the flexibility of their own subnet scheme
- Currently supported by EIGRP and OSPF

Any Questions

